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XI. *A Dissertation on those fossil figured Stones called Belemnites; communicated in a Letter from Mr. Emanuel Mendez da Costa to Martin Folkes, Esq; Pr. R. S.*

S I R,

Read Jan. 29.
1746-7.

THE Origin and Nature of the *Belemnites* having lately been greatly controverted, I have taken the Liberty to address to you the following Thoughts on that Subject; and beg, Sir, if you think them worthy your Regard, you would lay them before the *Royal Society*, as a due Testimony of the great Respect I have for that Learned and Illustrious Body.

The *Belemnites* is a Fossil of different Magnitudes and Colours, ever regular in Shape, which is either cylindric, conic, or thereunto approaching. Numbers of them have, on one Side only, a Chap or Seam running their whole Length; others have it in Part; and in others it is not at all to be observed: It consists of a talcy Matter, with an Intermixture of Spar or Crystal, disposed in *Strie* from or near its Centre to its Circumference, and is made up of Crusts inclosing each other, the innermost whereof is as regular as the outermost. Sometimes, tho' seldom, in comparison to the Numbers of the *Belemnites*, in the Centre is a Cavity ever conic, whatever the external Shape of the *Belemnites* be. This conic Cavity is at different times empty, or else filled, either with a solid Body of mineral Matter, Crystal, Stone, *Pyrites*, &c. or with

with a regular jointed conic Body, called by Lithologist the *Alveolus* of the *Belemnites*; which, tho' constantly regular and jointed, is nevertheless found composed of various mineral or metallic Substances.

The *Alveolus* above-mention'd, tho' not fully proved such, yet seems, by the Assent of most of the present Naturalists, to be a Body of marine Origin; a Shell the nighest related to the *Nautilus* Kind: It is concamerated, and even in some is discover'd another great Characteristic of the *Nautilus* Kind, I mean the Gut or *Siphunculus*. Therefore, taking this Body for granted to be of marine Origin (for what Reasons, or of what Kind, is not my present intended Subject to prove) it remains to discuss, Whether this Body became accidentally lodged in the *Belemnites*? or, Whether the *Belemnites* itself is also of marine Origin, and a Part dependent on its *Alveolus*?

Various have been the Opinions of Lithologists concerning the Origin of the *Belemnites*; some have even asserted them of the Vegetable Kingdom; others, that they are Teeth or Horns of Fish, Appendages of Shells, Bodies cast in Shells of the *Tubuli* Kind, or the very Shells themselves, Spines of *Echini*, or a kind of strait *Nautilus*. The three last Opinions are what I shall strive to confute, as they seem somewhat probable, and are now the most prevailing; and prove the *Belemnites* to be a natural Fossil or *Lapis sui generis*. I desire no Recourse to the Subterfuges used by others, but hope, Sir, you will agree with me in the Axiom, that all *Belemnites* are of one and the same Origin.

That

That the *Belemnites* are not Teeth or Horns of Fish, I shall refer you to the Letter your late learned Member Dr. *John Woodward* wrote on that Subject to Mr. *Bourguet*, of *Switzerland*, wherein he fully proves the Erroneousness of those Opinions. But a further Argument against their being Teeth, which that learned Naturalist has not touch'd upon, is, that no *Belemnites* have that natural Varnish or Polish, which always covers the Teeth of all Animals; whereas the greatest Part of those fossil Bodies, which we know to be such, as the *Bufonitæ*, *Glossopetræ*, &c. are found with that same Varnish or Polish. As for their owing their Form to being moulded in Shells, it will appear contradictory to Reason, when we consider, 1°. Their Constitution to be ever as regular as their Figure; and, 2°. That their inner Layer or *Nucleus* is as equally regular as the outer Crust or whole Body; which Particular could never have happen'd, had they been moulded in Shells; as is evident, by the *Turbinitæ*, *Conchitæ*, and other Bodies, which owe their Figures to that Cause. That the *Belemnites* are not Spines of *Echini*, let us first consider, that no Kinds hitherto discover'd have been ever found to have Spines analogous to these Bodies; nor indeed has any marine Shell whatever such a Texture. The immediate Subterfuge for an Answer to this Objection is, that the Kinds of Shells unknown to Mankind are far more in Number than those yet discover'd. I allow it; but think that cannot be an Argument in the present Case, since no one single Species is yet discover'd with such, nor even any *Genus*, which have Spines analogous to the *Belemnites*.

nites. Nature bears an Analogy through all her Works; and though all the Species of any one *Genus* is not known to any Man, yet that Analogy nevertheless capacitates us to judge of those undiscover'd by those we know. Thus we find of the *Echinus* Kind, all the Species now known are ever found near the Shores; consequently, are not subject to be eternally hidden from us; as is undoubtedly the Case of the *Cornua Ammonis*, and *Conchæ anomia*. They are no pelagian Shells, as those are; Bays and Harbours are the Places where they are fish'd; their Structure even evinces the Reasons for it. We may therefore with Probability conclude, that all the *Echinus* Kind are of the same Nature, and have the same Way of living; that they only inhabit such Places, and that none are pelagian Shells; consequently might have been discover'd.

I am sensible there are some Species of fossil *Echini*; as, the most common *conoid* or *pileated Echini*, the common *Echini galeati*, the *Echini clypeati*, and some Kinds of the *Echini ovarii*, &c. which tho' we are certain that they have been marine Shells, yet those particular Species are not known in the Sea: But then several other Species of that same *Genus* are. The Case of this is quite different, since not one single Species of such a *Genus* has ever been found.

The excessive Bigness and Thickness of Numbers of *Belemnites* described by Authors, *viz.* of near two Feet in Length, and above two Inches in Diameter in the thickest Part, others of three Feet long, and others as thick and long as a Man's Arm; not to enumerate those only under a Foot Length, and of proportionable

proportionable Thicknesses, concludes *Echini* of a vast Bigness, to have a Number of such Spines to move.

The Varieties of the *Belemnites*, how can they quadrate to the Spines of one *Genus* of *Echini* only? Solid *Belemnites*, *Belemnites* with a single Crust, or like a Tube, with a conic Cavity only; that empty, or otherwise filled with a solid Mass, or with a regular jointed Body, as the *Alveolus* — *Belemnites* of various Magnitudes and Thicknesses, &c. can all these Varieties be imagined to belong to one *Genus* of Shells, which we suppose to exist to maintain a favourite System?

The Number of Species of *Echini* discover'd are numerous; and the Spines of all those agree in having a hollow *Axis*, which runs proportionably from their *Basis* to their *Apex*, quite different to the *Belemnites*: And for their Constitution, a foreign Naturalist, a Member of the *Royal Society*, Mr. *Klein* of *Dantzick*, who has professedly wrote on this Subject, could only find of two Kinds, *viz.* those of a porous Constitution, which he observed only to belong to one *Genus*; and those of a solid shattery Substance, like a talcy Spar not striated; which is the most general, and is exactly the same Constitution as all the fossil Spines, or *Lapides Judaici* are.

Further, the *Lapides Judaici* have, at some times, been found adhering to their *Papillæ* or Tubercles, and with Fragments of their Shells; whereas no Naturalist has ever known to be found fossil either the Shells, or the Fragments of such a *Genus* of *Echinus*; not even any Remains proportionable to

such large Spines.—In whatever manner the greater Part of such Shells may have perish'd (which is unlikely, if we consider their Texture and Strength), some must have escaped, when the Spines are found in such excessive Numbers every-where, and always perfect and regular; whereas the fossil Spines, or *Lapides Judaici*, as they are call'd, as likewise the *Echini* or Shells, and all the fossil Bodies of marine Origin, are found broken and shatter'd in all kinds of Manners.

As for their being Shells of the *Tubuli* Kind, my Reasons against it are; Were the *Belemnites* such, they must be all tubular more or less; or otherwise must have suffer'd some Degree of Petrification to fill up their Cavities. The Unreasonableness of that Argument is demonstrated by all *Belemnites* being of one and the same Texture and Constitution; tho' Numbers are solid, and Numbers are tubular, in different Degrees. Now one Kind of Petrification, or any other Change in the Earth, which they might have undergone, could never have given so regular a Texture and Substance, and cause such different Effects as Solidity and Tubularity. And if, on the other hand, we allow it to be inconsistent, as it is, to form the Idea of a Shell of the *Tubulus* Kind, by a solid Body, without that Body having suffer'd some Change in the Earth, while buried in it, we must either deny all solid *Belemnites* to be such *Tubuli*, and run to Subterfuges, by owning them to be natural Fossils; or else allow a great Inconsistency, to uphold a wrong System.

That the *Belemnites* are not a tubular Case, which is Part of, and covers a Shell of the *Nautilus* Kind,

as

as is its *Alveolus*. The Variety of Circumstances already alleged of the *Belemnites* serve to demonstrate the Improbability also of this Opinion, as it has done of the other two. The Numbers of *Belemnites* of all kinds, so plentiful every-where, and the Consideration of how few are furnish'd with *Alveoli*.

Numbers, I am sensible, have conic Cavities; but that those Cavities never did contain *Alveoli*, is evident; that the Sides of the said Cavities are even, and without any circular or other Impressions, which a *Belemnites* that has ever contained an *Alveolus* must have; that Body being in close Contact to all Parts of the investient *Belemnites*, must consequently impress it with its Concamerations; which Impressions must be therefore found on the Sides of the Cavities of all *Belemnites* which ever contained them.

As for asserting, that all the *Alveoli*, which are now found loose, were originally lodged in *Belemnites*, it cannot be; without inferring also, that all *Belemnites* which are now devoid of *Alveoli*, contained such formerly; which, by some external or other Agent, have been forced out and loosened from them.

To consider such an Agent, we must also conclude its Force to have been exceeding great, to loosen out the *Nucleus* of a Body in close Contact with all its investient Parts; and strengthen'd further to it by Ridges and Grooves, such a Force must have compress'd, shatter'd, and otherwise broken and destroy'd the *Belemnites* that contain'd them; which is contrary to Observation. Further, forcing out the *Alveolus* might perhaps easily have happened to the conic *Belemnites*; which hath a Basis of a larger
Diameter

Diameter than the Middle, where the *Alveolus* is lodged; but we cannot conceive the same by the cylindric, fusiform, and other *Belemnites*, of which the two Ends or Extremes terminate pointed; while the Middle, where the *Alveolus* is lodged, is thick and swell'd.

To force an *Alveolus* out of such shaped *Belemnites*, it is evident, that the narrow Ends of the said *Belemnites* must be quite forced open, broken, and shatter'd, before a broader and more capacious Body could be forced through, especially to such a brittle shattery Fossil as the *Belemnites* is. The evident Facts to the contrary of this are also too common to insist on, since all these *Belemnites* are ever found regular, perfect, and intire.

Further, let us consider the *Alveoli* which are now found in *Belemnites*, they are very seldom if ever found as mere Shells, but ever differently changed or petrified. They are moulded of Stone, *Pyrites*, Crystal, &c. Now it can never be argued, that the contained Bodies can ever be so differently changed or petrified in their Covers or Shells, and those Covers or Shells which admitted such different petrifying Particles to undergo no Change or Petrification whatsoever.

Another Proof against this Opinion, is the diverse Forms of *Alveoli* now discover'd by Naturalists, as conic, cylindric, curved, spiral at the *Apex*, &c. whereas all *Belemnites* which have Cavities have none but conic ones.

These cylindric, &c. *Alveoli* are now found in *Pomerellia* in *Poland*, in the Marble of the Island of *Oeland* in the *Baltick Sea* belonging to *Sweden*, and in the Marble of *Sweden*; in *Gothland* in
Masses

Masses of Building-Stone; in *Ingria*, in several Parts of *Prussia*, &c. and are commonly of an immense Bigness, to several Feet in Length, and proportionably thick, yet not perfect. For such *Alveoli*, which are only *Nuclei*, we must suppose immense large *Belemnites*; and such we have never heard of, so with Probability we may conclude none such to exist.

I do not doubt the Growth of this Error, of the *Belemnites* being a Part of its *Alveolus*, to have been caused by too rash Conclusions, and too little an Insight into the fossil Kingdom; which has propagated that Assertion of the *Alveoli* being found only in the *Belemnites*; which Experience daily contradicts, since we find them loose, as well as imbedded in many other fossil Substances, as in Marble, Stone, &c. as has been above observed.

These are the Arguments which I allege, Sir, for the Improbability of the said Opinions. I could advance a Number of other Proofs; but as I have already extended my Letter beyond a due Length, I beg Leave, before I conclude, only to offer some few Reasons for their being a natural Fossil, or *Lapis sui generis*.

The very View of a *Belemnites* sufficiently evinces its mineral Origin, and shews it evidently composed of two fossil Substances, a Talc, and a Spar, or bastard Crystal; whereof the former is the Basis, and from which Principle I do not hesitate to attribute its striated Texture. Most of the talcy Bodies are of a fibrous Nature, and several are composed of Crusts inclosing each other, in the same Manner as the *Septa* of the *Ludus Helmontii*, some of the *Asbestos* kind, the *Hematites* Crusts, &c. Of the *Stalactites*

laſtites Tribe there are ſeveral, which ſo intirely approach the Texture and Conſtitution of the *Belemnites*, that were their Shapes a little more regular, the moſt experienced Lithologiſt might eaſily be deceived: And I remember, when abroad, to have ſeen ſuch, of a prodigious Bigneſs, which, tho' I was then ſomewhat converſant in the foſſil Study, I could not help taking for *Belemnites*. I do not therefore wonder, that *Petrus Affaltus, in notis ad Metallothecam Mercati*, p. 282, and *Langius, Hiſt. Lap. figurat. Helvetiæ*, p. 133. ſhould judge them a native figured Foſſil, formed in the Earth, of the *Stalactites* kind, if that Term for the *Belemnites* might with Propriety be uſed.

The Cavities of *Stalactites* in ſome meaſure illuſtrate, and are adequate to the Cavities of *Belemnites*; they are placed in as various Poſitions, and are only different from them by not being exactly conic. As for the regular Figure of the *Belemnites* being excepted againſt, I believe few Foſſiliſts will argument that, when we ſee as perfect regular Figures in the foſſil Kingdom as in any other Parts of the Creation; as witneſs the Salts and Cryſtals of all Kinds; the rhomboid, hexagonal, columnar, and other *Selenites*; the cubic, octangular, dodecaedral, and other *Pyrites*; the quadrangular Pyramids of Tin, the Rhombs of Iron, Cubes of Lead, and infinite other native Foſſils, which would take up Time to enumerate, and which are far more perfect Figures than the *Belemnites* are. Chymical and other Trials and Teſts (which I hope to have the Honour to lay before you in ſome future Letter) demonſtrate a greater Certainty of its mineral Origin.

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As for that marine Body the *Alveolus*, I cannot think otherwise than that it is of the *Nautilus* Kind; and which, at the Concretion or Formation of the *Bellemnites*, became accidentally lodged in its Cavity, in the same Manner as all other marine Bodies became lodged in the various fossil Substances we now find them in.

I beg, Sir, to remark, that the searching into the Origin of this Body is not merely curious, but of great Use; since, if its Origin is fully asserted, we are then better capacitated to search into the Properties and Uses of this Stone, which I do not doubt are many, and which we could never have attain'd to, without first having examined this principal Part of its History. I am,

S I R,

London, Dec. 27.
1746.

Your most obedient,

humble Servant,

Emanuel Mendez Da Costa.